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ABSTRACT

Previously reported methods for the compilation of core lists of journals in multidisciplinary areas are first examined, with toxicology used as an example of such an area. Three approaches to the compilation of a core list of journals in toxicology were undertaken and the results analyzed with the aid of models. Analysis of the results of the three approaches yielded six factors that need to be considered in the compilation of an authoritative core list of journals for toxicology. A list of the highest ranking journals, identified by these methods from among several hundred journals, as being of relevance to toxicology is given. Methods by which such a core list can be derived are outlined. (Author/MR)

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METHODS FOR THE COMPILATION OF A CORE LIST OF JOURNALS IN TOXICOLOGY

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T. D. C. Kuch

March, 1976

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Contents

List of figures and tables 4

Abstract 5

Introduction 8

Unresolved problems in core list compilation 8

Toxicology 11

Methodology 12

Approach 1 13

Approach 2 20

Approach 3 21

Comparison of the three approaches 23

Proximity to the research front 25

Relevance and the three approaches 26

A core list of journals in toxicology 28

Summary 37

Appendix 1: Summary of citations from three toxicology journals 38

References 40

Appendix: Author's remarks during presentation of the preliminary version of this paper at ASIS-1976 44

List of figures and tables

Table 1: Model of an "ideal" distribution of journal titles 15

Table 2: Model of a "real" distribution of journal titles 16

Table 3: Twenty highest ranking journals from Approach 1 17

Table 4: Characteristics of eight monographs 18

Table 5: Most-cited journals from each of eight monographs 19

Table 6: Model showing occurrences of citations to four journals in five monographs 20

Table 7: Twenty highest ranking journals from Approach 2 22

Table 8 [not included in this revision]

Table 9: Twenty highest ranking journals from Approach 3 24

Figure 1: Approximate placement of various journals on the research continuum 27

Table 10: Core list of journals in toxicology 29

Figure 2: Approximate placement of various disciplines and mission-oriented areas on the research continuum . . 36

Table 11: Highly cited journals from two leading toxicology journals 39

abstract

METHODS FOR THE COMPILATION OF A CORE LIST OF JOURNALS IN TOXICOLOGY

T.D.C. Kuch

Previously reported methods for the compilation of core lists of journals in multidisciplinary areas are first examined, with toxicology used as an example of such an area.

Three approaches to the compilation of a core list of journals in toxicology were undertaken and the results analyzed with the aid of models.

Approach 1 consisted of collating core lists offered in contract proposals for the preparation of monographs on a wide variety of topics in toxicology. Lists varied in length from 30 to 300 titles; a model was devised to account for this.

Approach 2 consisted of analyzing references to journals contained in substantial toxicity monographs prepared by or for several different Federal health agencies. A second model was devised to balance the importance of journals cited heavily in a few monographs vs. journals cited less heavily, but in several monographs.

Approach 3 consisted of presenting a list of highly ranked journals from approaches 1 and 2 to a panel of toxicology information professionals for rating as a core source, or of less importance.

Analysis of the results of the three approaches showed that the compilation of an authoritative core list of journals for toxicology requires consideration of these factors:

1. The scientific discipline(s) primarily addressed by a candidate journal;

2. The approximate placement of each discipline on a continuum from basic to applied research;

3. The approximate placement of each journal on a continuum from basic to applied, within each discipline addressed by that journal, to the extent that a given discipline is not strictly either basic or applied;

4. The approximate placement of the use to be made of a given core list on a continuum from basic research to literature compaction;

5. Citation patterns of each journal on a continuum from not cited to heavily cited;

6. Citation patterns of each journal on a continuum from highly erratic to highly consistent.

Of the several hundred journals identified by these methods as being of relevance to toxicology, the highest ranking were as follows, arranged by Index Medicus category. (Note that several journals appear in more than one category.)

Pharmacology

Acta pharmacologia et toxicologia
Biochemical pharmacology
Food and cosmetic toxicology
Journal of pharmacology and experimental therapeutics
Toxicology and applied pharmacology

Biochemistry

Biochemical journal
Journal of biological chemistry
Nature
Proceedings of the society for experimental biology and medicine
Science

General Medicine

British medical journal
Journal of the American Medical Association
New England journal of medicine

Experimental Medicine

Proceedings of the Society for Experimental Biology and Medicine
Science

Biology

Nature
Proceedings of the Society for Experimental Biology and Medicine
Science

Physiology

Proceedings of the Society for Experimental Biology and Medicine

Public Health

American journal of public health

Neoplasms

Cancer
Cancer research
International journal of cancer
Journal of the National Cancer Institute

Chemistry

Analytical chemistry
Journal of agricultural and food chemistry

Environmental Health

Archives of Environmental Health
Environmental Research

Science

Nature
Science

Industrial Medicine

American Industrial Hygiene Association journal
Annals of occupational hygiene
Archives of environmental health
Archives of industrial hygiene and occupational medicine
British journal of industrial medicine
Industrial medicine and surgery
Journal of occupational medicine

Introduction

A core list of journals for a discipline consists of a number of journal titles which, taken collectively, contain a desired proportion of total journal articles relevant to that discipline. This proportion may be established to approximate any level from 100% (total recall), to any arbitrary lower figure.

From the work of Bradford (1948) and others, we can estimate, given the n most essential journals, the total number of journals containing relevant articles, the total number of relevant articles, and the number of journals necessary to provide any approximate percentage of recall. This work has been summarized most usefully by Salton (1975).

While it has been a highly successful bibliometric technique, this approach has nevertheless left certain unresolved problems. This paper will address these and attempt preliminary answers, using the multidisciplinary area of toxicology as an example.

Unresolved problems in core list compilation

If we wish to construct a list of highly cited journals for a particular area, we know from the work of Garfield (1975d, for example) and others how to go about it:

1. Identify an initial candidate core list of journals
2. Analyze patterns of citations to and from these journals.
3. Refine the list in the light of knowledge gained in step 2.

The first of these steps has not yet been systematically addressed in the literature, and is the primary subject of the present paper.

Considering Garfield's work, we find the following methods used to identify the initial candidate core list:

1. Use of category indications in the Science Citation Index Guide (Garfield, 1974f, 1975a, 1975b, 1975d, 1975e, 1975f).
2. Use of category indications in SCI, narrowed apparently by examination of words in titles (Garfield, 1974h).

3. Examination of words in titles (Garfield, 1974d).

4. Use of "our experience or by their [the journals'] own description" (Garfield, 1974c).

5. Use of outside experts (Garfield, 1972b, 1974g).

6. Use of one obvious journal title (Garfield, 1974e).

The first of these methods is clearly derivative, depending upon some prior method of categorization * .

The remaining five methods, and others that might be proposed, can be placed in the following schema:

Judgmental methods

Examination of words in titles (methods 2, 3, 6 **).

Examination of stated journal editorial policies (method 4).

Examination of words in article titles contained in the journal.

Examination of texts of articles contained in the journal.

Survey of practicing journal users: scientists (method 5).

Survey of practicing journal users: information specialists (method 5).

Survey of practicing information providers (method 4).

Algorithmic methods

Auto-indexing and counting of discipline-dependent

---

* The SCI categories were used by Moore (1973) as source data in an examination of the interrelationships of disciplines. Unfortunately, he did not discuss the method used in assigning journal titles to the categories.

** Dym (1973) used this method. "A grand total of 42,240 primary serial titles were identified, and, of these, 16,662 were considered, based upon a review of the title of the publication, to possibly contain material of toxicological-biological interest."

terms.

Citation analysis.

Cluster analysis of citations (Carpenter, 1973; Narin, 1972).

Methods combining judgment and algorithms.

When the candidate list is refined during the citation analysis process, journals that should not have been excluded can be identified and included (Garfield, 1975d), and journals that should not have been included can also be identified, and omitted or placed very low on the final list (Garfield, 1974g).

The first problem with this approach is that all citations given in candidate journals are analyzed. This presumes that all articles in the selected journals are relevant to the extent that the journal itself is relevant, and reflect the quality of the journal as a corpus * . In a multidisciplinary field, however, certain methodological papers may be highly relevant, while other papers in the same journal may be of very low relevance. This may not be true when a discipline is well defined, such as chemistry, and when a journal is dedicated to that discipline, such as the Journal of the American Chemical Society. The problem also does not exist in the selection of core articles, provided that one has selected the proper articles as a starting point (Garfield, 1975g).

The second problem is that the nature of relevance itself is not well understood (Saracevic, 1975).

The third problem is that the relationship of relevance to quality has not been satisfactorily elucidated.

The fourth problem is that the concepts of relevance and quality, even if adequately defined, may not be sufficient to explain why a journal may be considered 'core' to a particular discipline, and another may not be.

The fifth problem is that it has not been definitively shown that the citation analysis process is adequate to perfect an erroneous candidate core list, although it is clear that the candidate list can be improved (Garfield, 1974g, 1975d).

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* This is an algorithmic presumption, made even though the information scientist involved is aware that it is not the case (Garfield, 1973).

As a framework for answers to these questions, we consider the science of toxicology.

Toxicology

According to Loomis (1974), toxicology is "the study of the effects of chemicals on biologic systems, with emphasis on the mechanisms of harmful effects of chemicals and the conditions under which harmful effects can occur." It is "a basic science." It is also a multidisciplinary field, and requires "a background in all of the basic physical, chemical, and biologic subjects."

The most relevant of these sciences, according to Loomis (1974) is pharmacology; of slightly less significance are biology, chemistry (especially biochemistry), pathology, physiology, public health, and immunology; and also essential, but of less central concern, are statistics, industrial health, veterinary science, marine biology, pollution engineering, and occupational medicine.

The President's Science Advisory Committee (1966:2) wrote in very similar terms.

Rall (1976) defines the field somewhat more broadly: "Toxicology, the science which studies, inter alia, the consequences of introducing toxic agents into the human ecology, is a broad umbrella covering many disciplines", including such diverse fields as analytical chemistry, molecular biology, human and veterinary medicine, genetics, and physics. The toxicologist is concerned with agricultural chemicals, hazardous industrial materials, household poisons, toxic drugs, pollutants from "radiation, heat, noise, endogenous and exogenous biotoxins, and much more."

Toxicology therefore occupies a place in the sciences similar to, but also distinct from,

- Disciplines properly so called;
- Multidisciplinary areas;
- Mission-oriented areas.

The seven chapter titles of the Toxicology research projects directory (Toxicology Information Subcommittee, 1976:iii) are:

- Agricultural, industrial, and household substances
- Drugs, medical materials, food additives, and cosmetics
- Physical agents and gases [including radioactivity]

. Metals, minerals, and trace elements
. Biotoxins
. Multiple and unspecified agents
. Environmental problems

According to Hersey (1976), this provides "a general overview of toxicology."

This is in part a separation by regulatory jurisdiction or agency mission, and in part a separation by scientific discipline. As will be seen below, the journals most heavily used in toxicology tend to separate into groups along the two dimensions of mission and discipline, the first being more apparent in applied science journals, and the second predominating in basic science journals.

Methodology

From the preceding discussion, it is apparent that research in toxicology requires use of the literature not only of toxicology per se, but also of several other fields of knowledge. As Kissman (1976) wrote, "The multi-disciplinary nature of toxicology makes information transfer in this field particularly difficult because toxicology cannot ride existing, discipline-based information systems."

Compilation of a core list of journals in toxicology is therefore not simple: journals in other disciplines may well be as relevant as those few specifically devoted to toxicology.

Before citation analysis can proceed, a good candidate core list of journals must be compiled. This paper presents the results of three approaches:

. Approach 1: consolidation of candidate lists from proposals offered by providers of information.
. Approach 2: tabulation of references in literature reviews and analyses on a variety of specific topics in toxicology.
. Approach 3: tabulation of expert opinions.

Each of the three approaches generates a different core list which, when compared, reflects the strengths and weaknesses of each approach. This comparison was aided by examination of previously offered core lists (Brandon, 1975; National Referral Center, 1969; Toxicology Information Response Center, 1975); of 1426 journal citations from the Journal of pharmacology and experimental therapeutics; and of 1098 journal citations from Toxicology and applied pharmacology.

Approach 1

In 1975 the Consumer Product Safety Commission issued a request for proposals (RFP) entitled "Monograph preparation", in support of our research into hazardous chemicals present in consumer products. A "monograph" was defined as "a separate written account of an object or class of objects. A monograph is thorough and definitive, but not necessarily exhaustive." Monographs, in this specialized sense, are often called "criteria documents".

Examples of topics were given in the RFP as a guide to the wide variety of toxicity problems to be assessed:

- vinyl chloride
- 1,1,1-trichloroethane
- halogenated hydrocarbons as propellants
- flame retardants, THPC, and other phosphoniums
- ingested hazardous substances (biological mechanisms)
- optical brighteners
- vinyl acetate monomer
- formaldehyde
- methyl amyl ketone and related ketones

Each respondant to the RFP was required to include a list of core sources of information in three parts: primary, secondary, and tertiary, following the usual distinction. "The core list", the RFP stated, "should be broad enough to encompass most of the relevant studies, but not so broad as to entail searching effort greater than a reasonable minimum."

Sixteen proposals were received, of which twelve included the required list of primary sources. Respondants included both for-profit and not-for-profit firms, university-affiliated and otherwise. About half were situated in the mid-Atlantic states, half in other parts of the United States. Most of the firms known as major contract monograph producers for Federal health agencies responded.

Lists of primary sources contained in the twelve proposals varied in length from 28 to 304 journal titles, with a mean of 92.3 titles and a median of 76. The sum of the lengths of the lists was 1107, with 550 distinct titles being given. Half the titles, therefore, appeared in one list only, and half on two or more lists. No title appeared on all twelve lists, but two appeared on eleven of the twelve.

It follows from Bradford (1948), that there can be no one "best" length for a core list: the most suitable length must depend upon the resources available, and the desired recall percentage. As these two factors were purposely not specified in the RFP, it was not possible to rule out any candidate list

as being a priori too long or too short.

In order to combine the twelve lists into one ranked list, formula 1 was devised and tested:

$$\text{journal score} = \sum^{N} \frac{t_{ij}}{L_i} \qquad (1)$$

where N is the number of lists, L_i the length of list i, and t_{ij} =1 if journal j appears on list i, and 0 if it does not.

Formula 1 takes into account a consequence of Bradford's Law: ideally, a title on a shorter list is more relevant than a title on a longer list. It would seem, therefore, that a title appearing on a shorter list must be given more weight than a title on a longer list. A title appearing only on longer lists can be assumed to be of marginal relevance.

In theory, a series of candidate lists will conform to the model given in table 1. Decreasing relevance is clearly shown, and the entire collection of journals conforms to Bradford's Law, rank times occurrence for each title being approximately constant.

In this ideal distribution, a simple count of occurrences is adequate to assess relative relevance and to construct a core list. Formula 1 is also adequate, and will yield the same results.

In reality, however, a series of candidate lists is more apt to resemble the model given in table 2. Journal jA is obviously the highest-ranking title, but the relative ranks of some others are not so obvious; and a "worst case" has been included, that of a title (jH) appearing but once, and that on the shortest list.

Occurrence counts alone are not sufficient to distinguish among journals occurring on lists of various lengths, and the application of formula 1 also results in an unwarranted conclusion--that journal jH is to be ranked immediately below journal jA, clearly an inappropriate ranking.

In order to account for these non-ideal situations, formula 2 was developed and tested:

$$\text{journal score} = \sum^{N} \frac{t_{ij}}{L_i} + \left(\sum^{N} t_{ij} \div \frac{\sum L_i}{N} \right) \qquad (2)$$

journal titles	list					
	L1	L2	L3	L4	L5	L6
jA	x	x	x	x	x	x
jB	x	x	x	x		
jC	x	x	x			
jD	x	x				
jE	x	x				
jF	x					
jG	x					
jH	x					
jI	x					
jJ	x					
jK	x					
jL	x					

Table 1: Model of an "ideal" distribution of journal titles among six lists of candidate titles for a core list.

journal titles	list						
	L1	L2	L3	L4	L5	L6	L7
jA	x	x	x	x	x	x	
jB	x	x	x	x			
jC	x	x		x			
jD		x	x		x		
jE	x	x					
jF	x				x		
jG						x	
jH							x
jI	x						
jJ	x						
jK	x						
jL	x						

Table 2: Model of a "real" distribution of journal titles among seven lists of candidate titles for a core list.

rank	normalized score	title
1	.911	Cancer research
2	.862	Toxicology and applied pharmacology
3	.856	Journal of the National Cancer Institute
4	.749	Nature
5	.725	Archives of environmental health
6	,722	Acta pharmacologia et toxicologia
7	.710	Food and cosmetic toxicology
8	.685	Clinical toxicology
9	.673	Pharmacology and toxicology [USSR]
10	.664	Journal of biological chemistry
11	.661	Proceedings of the Society for Experimental Biology and Medicine
(12	.633	Analytical chemistry
(12	.633	Teratology
14	.621	Cancer
15	.618	Bulletin of environmental contamination and toxicology
16	.609	Biochimica et biophysica acta
17	.602	Science
(18	.587	Analytical biochemistry
(18	.587	Biochemical journal
20	.578	Life sciences

Table 3: Twenty highest ranked journals from Approach 1.

mono-graph	topic	sponsor	*1	*2	*3
M1	cotton dust	National Institute for Occupational Safety and Health (NIOSH)	35	100	2.86
M2	fluorocarbons	Environmental Protection Agency	75	161	2.15
M3	trichloroethane, trichloroethylene, perchloroethylene	Consumer Product Safety Commission	38	87	2.29
M4	mannitol	Food and Drug Administration	21	33	1.57
M5	methyl ketones	Consumer Product Safety Commission	57	80	1.40
M6	asbestosis	National Center for Toxicological Research	75	246	3.28
M7	inorganic and organometal-lic compounds	International Agency for Research on Cancer	135	364	2.70
M8	drinking water	Environmental Protection Agency	126	289	2.29
totals			562	1360	n/a
means			170	70	2.42

key:

*1 = number of journals cited

*2 = number of references to journals

*3 = mean references per journal cited

Table 4: Characteristics of eight monographs on a variety of toxicological subjects.

monograph	rank	title	percent of all journal references
M1	1	British journal of industrial medicine	35.0
	2	Archives of environmental health	10.0
	3	Journal of occupational medicine	8.0
	(4	British medical journal	3.0
	(4	Public health bulletin	3.0
M2	1	Toxicology and applied pharmacology	13.0
	2	American Industrial Hygiene Association journal	6.2
	3	Journal of the American Medical Association	5.0
	4	Archives des maladies professionelles	4.3
	5	Nature	3.7
M3	1	Archives of environmental health	11.5
	(2	Toxicology and applied pharmacology	8.0
	(2	British journal of industrial medicine	8.0
	4	American Industrial Hygiene Association journal	7.0
	5	Archives of industrial hygiene & occupational medicine	5.7
M4	1	Journal of biological chemistry	15.2
	(2	Proceedings of the Society for Experimental Bio & Med	12.1
	(2	American journal of physiology	12.1
	(4	Biochemical journal	6.1
	(4	Biochimica et biophysica acta	6.1
M5	1	American Industrial Hygiene Association journal	6.3
	(2	Toxicology and applied pharmacology	5.0
	(2	Journal of biological chemistry	5.0
	(4	Journal of the National Cancer Institute	3.8
	(4	Public health reports	3.8
M6	1	Archives of environmental health	12.2
	2	American Industrial Hygiene Association journal	8.9
	3	British journal of industrial medicine	8.1
	4	Annals of occupational hygiene	7.3
	5	Medicina del lavoro	4.9
M7	1	Archives of environmental health	8.2
	2	British journal of cancer	6.3
	3	British journal of industrial medicine	4.9
	4	British medical journal	3.6
	5	Cancer research	3.0
M8	1	Journal of the American Water Works Association	12.1
	2	Public health reports	5.2
	3	Archives of environmental health	3.8
	4	Journal of the American Medical Association	2.8
	(5	Toxicology and applied pharmacology	2.4
	(5	British journal of industrial medicine	2.4
	(5	American journal of public health	2.4

Table 5: Most-cited journals from each of eight monographs.

or, the score from formula 1 plus (occurrence divided by the mean length of all lists).

Formula 2 was applied to both models successfully: resultant rankings corresponded to those intuitively acceptable. Then it was applied to the twelve candidate core lists. The maximum possible score was defined as 1.00, and other scores normalized from that point. Results of Approach 1 are given in table 3.

Approach 2

The second approach to the compilation of a core list of journals in toxicology consisted of tabulation of the references from eight toxicology monographs, representing a variety of topics and organizations. These eight are presented in table 4.

Although this selection of eight cannot be assumed to be representative of all toxicology monographs, the most-cited journals in each monograph show surprising consistency, as indicated in table 5: two titles were very highly ranked in five of the eight monographs; two titles in four of the eight; and four titles in two of the eight. This is all the more remarkable considering the differing missions and needs of the various monograph sponsors.

In order to combine the references from the eight monographs into one ranked list, the relative significance of the number of total references to a journal vs. the number of monographs containing a reference to that journal was considered with the aid of a model (table 6).

	monograph				
journal	M1	M2	M3	M4	M5
jA	5	0	0	0	0
jB	1	1	1	1	1
jC	2	2	1	0	0
jD	1	1	1	0	0

Table 6: Model showing occurrences of citations to four journals in five monographs.

Journal jA is highly cited in M1, not at all in M2-M5. It can thus be considered to be topic-specific or mission-specific (e.g., Journal of the American Water Works Association), and of less general disciplinary relevance than jB-jD. jC and jD occur in the same number of monographs, but jC has a high total occurrence count, and is therefore deserving of a slightly higher score.

A scoring scheme was devised in order to reward journals appearing at least once in several monographs, and to add less reward for each additional appearance in the same monograph: one point was awarded for the first reference to a journal in a monograph, plus 1/n for each nth appearance. Three appearances in a monograph would thus give 1.83 points to the journal cited (1.0 + 0.5 + 0.33).

The highest-ranking journal was defined as scoring 1.000, and the remainder were normalized from that base. Results of this tabulation are given in table 7.

Approach 3

Forty journals from approaches 1 and 2 were printed as a checklist with these instructions:

> Which journals do you consider 'key' or 'core' journals in toxicology? Please mark titles below that you consider vitally important in this area. Mark as many, or as few, as you wish. Do not select a journal merely because of a likely-sounding name.

In addition, three blank spaces were provided with the notation "Indicate here journals missing from this list that in your opinion should be included."

This checklist was given to members of the Toxicology Information Subcommittee of the Committee to Coordinate Toxicology and Related Programs of the U.S. Department of Health, Education, and Welfare. The members of the Subcommittee, in general, are middle-level administrators with science backgrounds. In order not to bias the results, no explanation of aims or methodology was made to the group before the survey.

Seventeen responses were received. Including writeins, 74 different journals received votes. Responses included a number of votes ranging from a low of five titles to a high of 67, with a mean of 17.1 and a median and mode of 14. No journal received the maximum possible 17 votes.

Journal titles were scored by applying formula 2 to the

rank	normalized score	title
1	1.000	Archives of environmental health
2	.823	British journal of industrial medicine
3	.749	American Industrial Hygiene Association journal
4	.661	Toxicology and applied pharmacology
5	.635	Journal of the American Medical Association
6	.592	Journal of occupational medicine
7	.575	British medical journal
8	.560	Annals of occupational hygiene
9	.553	Archives of industrial hygiene and occupational medicine
10	.501	Nature
11	.445	Lancet
12	.430	Journal of the National Cancer Institute
13	.425	Public health reports
14	.413	Science
15	.406	Journal of industrial hygiene and toxicology
16	.365	Journal of pharmacology and experimental therapeutics
17	.355	Biochemical pharmacology
(18	.344	Journal of biological chemistry
(18	.344	Proceedings of the Society for Experimental biology and medicine
20	.343	Biochemical journal

Table 7: Twenty highest-ranking journals from Approach 2.

survey results. Scores were then normalized by defining the maximum possible score as 1.000, yielding the ranking given in table 9.

In Approach 3 three journals have been highly ranked that are too new to have been cited extensively: Environmental health perspectives, Toxicology, and Journal of toxicology and environmental health, the first-issue dates of which are respectively 1972, 1973, and 1975. The first two of these journals appeared in the Approach-1 lists, but with low rankings; the third was too recent to have appeared in either Approach 1 or Approach 2.

Comparison of the three approaches

In order to begin the assessment of the merits of each approach, six cancer journals were selected for study:

- Cancer research
- Journal of the National Cancer Institute
- Cancer
- British journal of cancer
- International journal of cancer
- European journal of cancer

Garfield (1974g) found that these six were cited both by the scientific literature in general, and also by cancer journals as a group, in the order indicated above, Cancer research being the most highly cited. *

Analysis of 1426 consecutive journal citations in the Journal of pharmacology and experimental therapeutics and of 1098 in Toxicology and applied pharmacology showed the same order for the first three journals. Both also confirmed the low ranking of EJC, but both ranked IJC somewhat higher than BJC. **

With the exception of the relative rankings of IJC and BJC, therefore, the ranked list of six cancer journals above can be considered normative. Each of the three approaches was then

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* Garfield's "impact factor" (1974g), which corrects for one journal's publishing more papers than another, was not considered relevant to the present study, as we here consider the total impact of each journal, not the impact of a typical paper from that journal.

** Further results of tabulations of JPET and TAP citations are given in Appendix 1.

rank	normalized score	title
1	.867	Toxicology and applied pharmacology
2	.649	Environmental health perspectives
3	.588	Science
4	.493	Pharmacology and toxicology [USSR]
5	.489	Journal of pharmacology and experimental therapeutics
6	.484	Toxicology
7	.478	Cancer research
8	.469	Archives of environmental health
9	.443	Journal of biological chemistry
10	.431	Journal of the National Cancer Institute
11	.430	Nature
12	.405	British journal of industrial medicine
13	.353	Biochimica et biophysica acta
14	.350	Archives of industrial health and occupational medicine
15	.325	Food and cosmetic toxicology
16	.312	American Industrial Hygiene Association journal
17	.309	Clinical toxicology
18	.288	Journal of the American Medical Assoc.
19	.256	Journal of occupational medicine
20	.246	Analytical biochemistry

Table 9: Twenty highest ranking journals from Approach 3.

compared with the list, with these results:

- Approach 1 conformed to the normative list, with BJC ranked higher than IJC.

- Approach 2 failed to conform to the normative list, showing this ranking:

  1. JNCI
  2. BJC
  3. IJC
  4. Cancer
  5. Cancer research
  6. EJC

  } These three journals were closely bunched.

- Approach 3 conformed to the normative list except that JNCI was ranked slightly higher than Cancer research.

There is therefore some evidence that Approaches 1 and 3 provide useful information to users of the literature of chronic toxicology. Before we dismiss Approach 2 as being less useful, however, the possibility of other forces being at work must be considered.

Proximity to the research front

From Garfield (1974b) we know that in this country the New England journal of medicine is more research oriented than the Journal of the American Medical Association; that an analogous situation exists in England as between Lancet and the British medical journal; and that the Journal of clinical investigation, while providing a link between research and clinical practice, is proximate to the research front (Garfield, 1974a).

Considering the four lists from Approaches 1 and 2, Toxicology and applied pharmacology, and the Journal of pharmacology and experimental therapeutics, we will see where each lies in relation to the research front, and how this may be reflected in the rankings of journals on each list.

JPET is heavily cited by TAP: only self-citation and citations to Biochemical pharmacology outrank JPET on the list of journals cited by TAP (see Appendix 1). On the other hand, JPET cited 59 journals more than it cited TAP. Also, in the list of journals cited by JPET, JCI outranks any of the other medically oriented journals, placing 10th as against, for instance, a rank of 31st for NEJM and only one citation out of the 1426 for JAMA.

It is reasonable, therefore, to consider JPET closer to the research front than TAP.

TAP, while being farther from the front than JPET, appears to be nearer to it than the toxicology monographs examined in Approach 2: in the list of journals cited by TAP, Lancet and BMJ rank close together, as do JAMA and NEJM. This is illustrated in figure 1.

Figure 1 must be interpreted as showing general tendencies, not uniform placement: JAMA, for instance, often publishes new and significant findings, while the more "basic research"-oriented journals occasionally publish state-of-the-art reports, critiques, and the like.

Approaches 1 and 2 are concerned with the production of mission- or program-oriented literature reviews, using basic research as it may support applied conclusions, or as it may be directly applicable to program needs. One would therefore expect JAMA and BMJ, being more directly concerned with clinical findings as to the toxicity of given chemicals, to outrank NEJM and Lancet in these first two approaches; and we would also expect Approaches 1 and 2 to be consistent between themselves: journals proposed for use in monographs (Approach 1) should be those actually so used (Approach 2).

This is the case: in both approaches JAMA is ranked higher than NEJM, and BMJ than Lancet, precisely the opposite of the situation in JPET. In both approaches, also, JCI barely appears.

Measured by the relative rankings of these general medical journals, Approach 3 is on the "literature compaction" side of the continuum: JAMA and BMJ both rank higher than either NEJM or Lancet. This has come about probably because the experts surveyed in Approach 3 are not bench scientists but mission-oriented science administrators.

Relevance and the three approaches

Saracevic (1975), reviewing Cooper's work (1971, 1973), emphasizes the importance of utility as opposed to relevance, where "relevance has to do with aboutness (or pertinence or topic-relatedness)...whereas utility is a catch-all concept involving not only topic-relatedness but also quality, novelty, importance, credibility and many other things....The purpose of retrieval systems is...to retrieve documents that are useful, not merely relevant."

In this view, it would be easy to show that Cancer research and the European journal of cancer are equally relevant to toxicology studies: almost all articles in both journals are about a major type of chronic toxicity. This cannot, however, explain the uniformly higher rank, by both judgmental and algo-

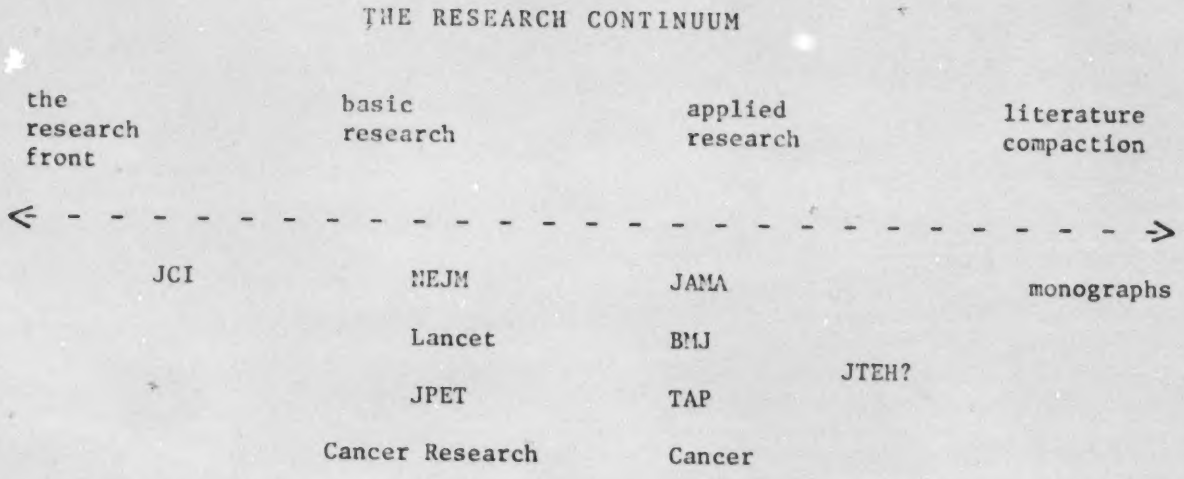

Figure 1: Approximate placement of various journals on the research continuum, from the viewpoint of toxicology.

rithmic methods, given to Cancer research. In order to explain this ranking, we must resort to use.

But "use" or "utility" has its own problems. In the writing of a monograph, to cite a typical but fictitious example,

- A literature search locates 300 documents.
- 20 are eliminated as false drops, leaving 280.
- 100 are eliminated as being outdated, overly difficult of access, or as addressing the topic from a point of view not central to the present concerns, leaving 180.
- The 180 are reviewed, and 80 are eliminated as repeating the methodology or conclusions of the 100 now remaining.
- 20 are eliminated owing to faulty methodology or dubious drawing of conclusions, leaving 80.
- 80 documents are reviewed and cited in the final monograph.

It seems clear that 280 documents are "relevant". What number of documents, however, are of "utility"? Only those 80 which were finally cited? Or did the examination of the remainder of the documents influence, perhaps improve, the resultant monograph? Answers to these questions are not obvious.

"Use", when coupled with the idea of the research continuum, explains the relative rankings of the general medical journals in a way that "relevance" cannot: the rankings of JAMA - BMJ and NEJM - Lancet differ depending upon the distance from the research front of the use to which the information is to be put.

Approaches 1 and 2 clearly relate to the literature-compaction side of the research continuum; JPET is closer to the "basic" side, while TAP is somewhere in the middle. JAMA is more useful than NEJM in the writing of toxicology monographs, but less useful the nearer one approaches the actual conduct of basic research. To the ongoing dialogue on relevance, therefore, must be added the place of use in relation to the research front, and it would seem that a core list of journals in a discipline will be of limited value unless it specifies at least an approximate distance from that front.

A core list of journals in toxicology

The results of approaches 1, 2, and 3, and citations from JPET and TAP, are summarized in table 10. Highly-ranked journals from each of the five methods are included, along with this other information, for purposes of comparison, for the highly ranked journals:

- The National Referral Center's "Some United States

Table 10 (see key following last page of table)

Class Pc: Pharmacology	Ap1	Ap2	Ap3	TAP	JPET	JTEH	NRC	BRN	ORNL	NIH	remarks
J PHARMACOL EXPER THERAPEUTICS	2	1	1	1	1	1	1	2	1	2	
BIOCHEM PHARMACOL	2	1	3	1	1	1	1	0	0	2	also in class Bc
FOOD COSMET TOXICOL	1	2	2	3	0	0	0	0	1	0	
TOXICOL AND APPLIED PHARMACOL	1	1	1	1	3	1	1	0	1	2	
ACTA PHARMACOL TOXICOL	1	3	3	3	3	0	n/a	0	1	2	
J PHARMACY AND PHARMACOL	2	3	3	1	2	0	n/a	0	1	2	
Arch toxikol	2	3	0	0	0	0	n/a	0	1	0	
Arch int pharmacodynam therap	3	0	0	2	1	0	n/a	0	0	2	
Clinical toxicol	1	0	2	3	0	0	1	0	1	0	
Critical reviews in toxicol	2	0	3	0	0	0	n/a	0	1	0	
Drug metabol disposition	3	0	3	0	0	0	0	0	0	0	
Life sciences	1	3	0	1	1	0	0	0	0	0	also in classes Bl, Bc, and Ps
Teratology	1	0	3	3	0	3	1	0	1	2	also in class Em
Clin pharmacol therap	2	0	0	3	2	0	1	1	1	0	
Pharmacol & toxicol (USSR)	1	0	1	0	0	0	n/a	0	1	0	
Pharmacol reviews	2	0	0	1	1	2	1	2	0	2	
Brit j pharmacol	2	0	0	2	1	0	n/a	0	1	2	
Eur j pharmacol	3	0	0	3	1	0	n/a	0	1	2	
Toxicology	1	0	1	0	0	0	n/a	0	1	0	
Bull environ contam toxicol	1	0	0	3	0	0	0	0	1	0	also in class Eh
Molecular pharmacol	0	0	3	2	3	0	1	0	0	0	
Class Bc: Biochemistry											
BIOCHEM J	1	1	3	1	1	1	n/a	0	0	2	
NATURE	1	1	2	1	1	1	n/a	0	0	1	also in classes S and Bl
J BIOLOGICAL CHEMISTRY	1	1	1	1	1	1	1	2	0	2	
PROC SOC EXPER BIO MED	1	1	3	1	1	1	1	0	1	2	also in classes Bl, Em, and Ps

(Class Bc: Biochemistry)	Ap1	Ap2	Ap3	TAP	JPET	JTEH	NRC	BRN	ORNL	NIH	remarks
SCIENCE	1	1	1	1	1	1	1	2	1	2	also in classes Bl, Em, and S
BIOCHEM PHARMACOL -- see class Pc											
Analytical biochemistry	1	0	3	3	0	0	1	0	0	2	
Arch biochem biophys	2	3	0	1	3	3	0	0	0	2	
Biochim biophys acta	1	0	2	2	1	0	n/a	0	0	2	
Biochem biophys res comm	2	0	0	2	2	0	0	0	0	2	
Biochemistry	2	0	0	0	3	0	1	0	0	2	
Clinical chemistry	3	3	0	0	0	0	1	0	0	2	
Life sciences -- see class Pc											
Proc Nat Acad Sciences (USA)	2	0	0	2	1	1	0	0	0	1	also in class Em
Class G: General medicine											
BRIT MEDICAL J	2	1	3	2	0	0	n/a	2	0	2	
J AMER MEDICAL ASSOCIATION	2	1	2	3	0	1	1	1	0	1	
NEW ENGLAND J MEDICINE	3	2	3	2	2	0	1	1	0	2	
Lancet	2	1	0	1	3	1	n/a	1	0	2	
J clinical investigation	0	3	0	3	1	0	1	2	0	2	
Class Em: Experimental medicine											
PROC SOC EXPER BIO MED -- see class Bc											
SCIENCE -- see class Bc											
Comptes rendus Acad Sci	2	2	0	3	0	0	n/a	0	0	2	also in classes Bl and S
Proc Nat Acad Sciences (USA) -- see class Bc											
Federation proceedings	2	0	0	1	1	2	0	0	0	2	also in classes Bl and Ps
Experientia	0	3	0	2	2	0	n/a	0	0	2	also in classes Bl and S
Teratology -- see class Pc											

Class B1: Biology	Ap1	Ap2	Ap3	TAP	JPET	JTEH	NRC	BRN	ORNL	NIH	remarks
NATURE -- see class Bc											
PROC SOC EXPER BIOL MED -- see class Bc											
SCIENCE -- see class Bc											
Comptes rendus Acad Sci -- see class Em											
Life sciences -- see class Pc											
Federation proceedings -- see class Em											
Experentia -- see class Em											
J cell biology	3	0	0	1	0	0	0	0	0	2	
Class Ps: Physiology											
PROC SOC EXPER BIOL MED -- see class Bc											
Amer j of physiology	2	0	0	1	1	3	1	2	0	2	
Life sciences -- see class Pc											
Federation proceedings -- see class Em											
J physiology (London)	3	0	0	2	1	0	n/a	0	0	2	
J applied physiology	3	3	0	3	3	0	0	2	0	2	
Class Ph: Public health											
AMER J PUBLIC HEALTH	2	2	3	0	0	0	1	1	0	2	
Public health reports	0	1	3	0	0	0	1	1	0	2	
Class Pt: Pathology											
Amer j clinical pathology	3	3	0	0	0	0	1	1	0	2	
Laboratory investigation	0	0	0	1	0	0	0	0	0	2	
Exper and molecular pathology	0	3	0	1	0	0	1	0	0	0	
Class C: Chemistry											
ANALYTICAL CHEMISTRY	1	2	3	2	0	0	0	0	0	2	
J AGRICULTURAL FOOD CHEMISTRY	2	2	3	2	0	0	1	0	0	0	

Class N: Neoplasms	Ap1	Ap2	Ap3	TAP	JPET	JTEH	NRC	BRN	ORNL	NIH	remarks
CANCER	1	3	3	0	0	0	0	1	0	2	
J NATIONAL CANCER INSTITUTE	1	1	1	3	0	1	1	2	0	2	
CANCER RESEARCH	1	3	1	2	3	1	1	0	0	2	
INTERNATIONAL J CANCER	2	3	3	0	0	0	n/a	0	0	2	
British j cancer	2	2	0	0	0	2	n/a	0	0	2	
Class Eh: Environmental health											
ARCH ENVIRONMENTAL HEALTH	1	1	1	1	0	2	1	2	1	0	also in class I
ENVIRONMENTAL RESEARCH	3	2	3	0	0	0	0	0	0	0	
Environ health perspectives	0	3	1	3	0	1	n/a	0	1	0	
J toxicol and environ health	n/a	n/a	3	n/a	n/a	n/a	n/a	n/a	1	n/a	
Bull environ contam toxicol -- see class Pc											
Class S: Science											
SCIENCE -- see class Bc											
NATURE -- see class Bc											
Annals New York Acad Science	2	2	0	1	1	1	1	0	1	2	
Comptes rendus Acad Sci -- see class Em											
Experientia -- see class Em											
Class I: Industrial medicine											
AMER INDUSTRIAL HYG ASSOC J	2	1	2	3	0	2	1	0	1	0	
ANNALS OF OCCUPATIONAL HYGIENE	2	1	3	0	0	0	n/a	0	0	0	
BRIT J INDUSTRIAL MEDICINE	2	1	2	2	0	0	n/a	0	1	0	
INDUSTRIAL MEDICINE & SURGERY	2	2	3	0	0	0	1	0	0	0	
J OCCUPATIONAL MEDICINE	2	1	2	0	0	3	1	0	1	0	
ARCH INDUS HYG OCCUPATIONAL MED	3	1	2	0	0	0	n/a	0	0	0	
ARCH ENVIRONMENTAL HEALTH -- see class Eh											
J Industrial hyg toxicol	2	1	0	0	0	0	0	0	0	0	

Class Gn: Genetics	Ap1	Ap2	Ap3	TAP	JPET	JTEH	NRC	BPN	ORNL	NIH	remarks
Mutation research	2	0	3	0	0	1	n/a	0	1	0	
Class Cv: Cardiovascular system											
Circulation research	0	0	0	0	1	0	0	0	0	0	
Class Pm: Pharmacy											
J pharmaceutical science	2	3	0	2	2	0	1	0	1	2	

Table 10: Core list of journals in toxicology, grouped by categories established by the National Library of Medicine for Index medicus. Journal titles in ALL CAPITAL LETTERS are those scoring at least "3" in Approaches 1, 2, and 3. See key, below, for the significance of the numeric scores.

Key to table 10

Ap1 = Approach 1 (12 lists from proposals)

1 = In the highest-ranking 20 journals for this approach.
2 = In the highest-ranking 1/8th of all journals for this approach, but not in the highest 20.
3 = In the highest-ranking 1/4th of all journals for this approach, but not in the highest 1/8th.
0 = Not in the highest 1/4th of all journals for this approach.

Ap2 = Approach 2 (8 lists from monographs). Same codes as for Ap1.

Ap3 = Approach 3 (expert survey)

1 = In the highest-ranking 10 journals for this approach (highest-ranking 1/8th).
2 = In the 11th through 19th ranking journals for this approach (highest-ranking 1/4th).
3 = Received two or more votes, but was not in the highest-ranking 19 journals for this approach.
0 = Received fewer than two votes.

TAP = Toxicology and applied pharmacology
JPET= Journal of pharmacology and experimental therapeutics
JTEH= Journal of toxicology and environmental health

Same codes as for Ap1 (above); see also Appendix 1.

NRC = National Referral Center (1969) list of toxicology periodicals.

1 = On the NRC list.
0 = Eligible for the NRC list, but not included.
n/a = Not eligible for the list because of foreign origin or began publication after the compilation of the list.

BRN = Brandon's (1975) list of journals for medical libraries.

1 = On the list.
0 = Not on the list.

ORNL= Oak Ridge National Laboratory, Toxicology Information Response Center (1975) preliminary list. Same codes as for BRN.

NIH = National Institutes of Health (1974) library list.

1 = Four copies of each issue acquired by NIH.
2 = Two copies of each issue acquired by NIH.
0 = Fewer than two copies of each issue acquired by NIH.

periodicals of toxicological interest" (1969);

- The Toxicology Information Response Center's "Toxicology-related journals--preliminary list" (1975);
- Brandon's "Selected list of books and journals for the small medical library" (1975);
- Journals two or more copies of which are received by a leading biomedical library (National Institutes of Health, 1974).

None of these four can be considered a core list as such, but each is of interest:

- NRC's list is multi-disciplinary, including a broad range of serials whose importance is confirmed by the findings of the three approaches.
- The TIRC list is closely confined to pharmacology and acute toxicology, de-emphasizing such areas as supporting disciplines and cancer.
- Brandon's list is, as one might expect, clinical in orientation, but nonetheless includes a number of journals in chemistry and other supporting disciplines, as well as a section on "pharmacology and therapeutics".
- The NIH Library subscribes to almost all biomedical journals of any significance; subscriptions for multiple copies reflect the library's experience in providing for the needs of members of the NIH community.

The Journal of toxicology and environmental health is included in the tabulation. For reasons explained elsewhere in this paper it is too early to define the scope of this new journal from citation analysis, but the table and Appendix 1 suggest that it may become a core journal, and also that it lies on the "literature compaction" side of the research continuum, along with such other serials as Archives of environmental health and British journal of industrial medicine.

Journals in table 10 were separated along disciplinary boundaries by use of the National Library of Medicine's List of journals indexed in Index medicus (1972). NLM did not indicate their methodology for the categorization of journals. For those few journals not appearing on the NLM list, categorization was done by analogy to that list.

The result of this grouping shows that several of the categories are themselves placed along the research continuum (figure 2). As might be expected, such categories as physiology

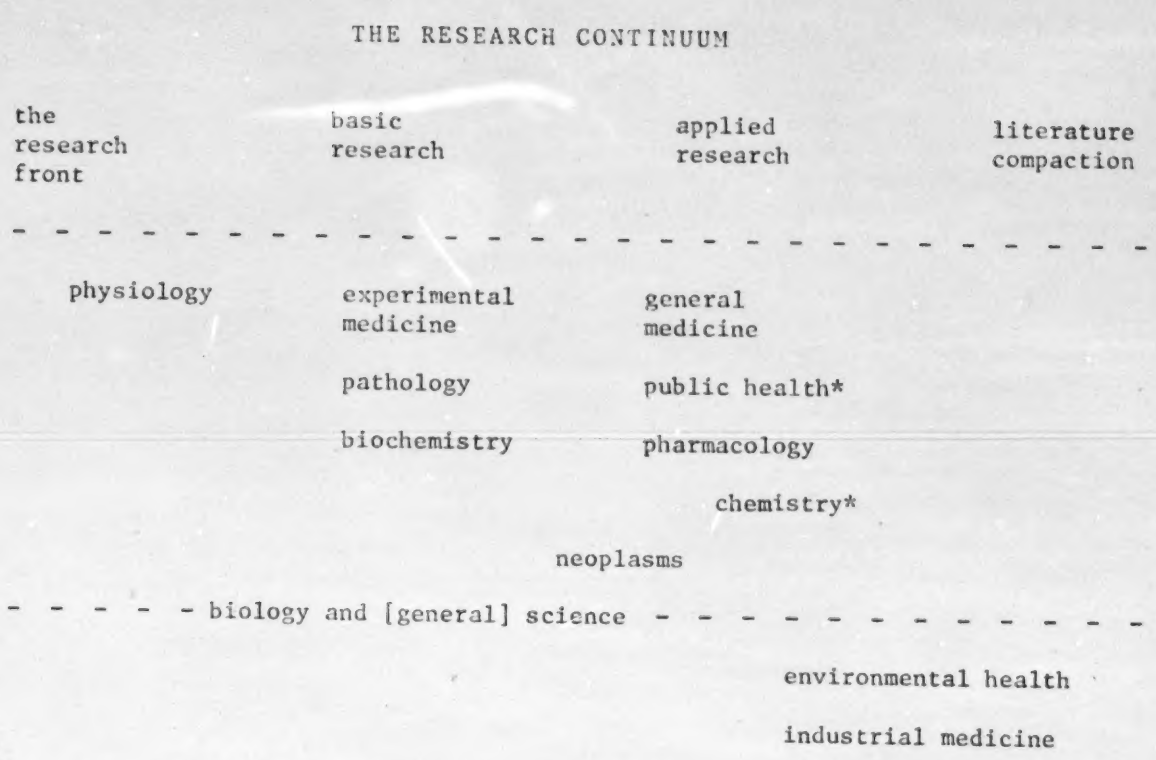

Figure 2: Approximate placement of various disciplines and mission-oriented areas on the research continuum, from the viewpoint of toxicology. * indicates areas containing only two core journals in toxicology (see table 10): owing to the small value of n the placement of these areas is less certain than the placement of other areas. Areas in which n=1 have not been included in this figure (genetics, pharmacy, and cardiovascular system).

and biochemistry tend to lie near the front (as measured, for instance, by higher scores in JPET than in Approach 1), while such categories as environmental health and industrial medicine lie farther to the right. Biology and (general) science categories were highly ranked all along the continuum.

While figure 2 again indicates general tendencies and not specific placement, a "left to right" (research front to literature compaction) arrangement of categories is suggested.

A core list of journals in toxicology for purposes of basic research can then be found by selecting titles from table 10 in categories on the left of figure 2, and a core list for applied or program purposes, or for summarization of research can be found by selecting titles in categories on the right side of figure 2. For both purposes, journals in the more general categories of science and biology should be considered core; and, as figure 2 is a continuum, regardless of purpose there will remain the need to examine papers from all titles, from left, to middle, to right.

Summary

Analysis of the results of three approaches showed that the compilation of an authoritative core list of journals for toxicology requires consideration of these factors:

- The scientific discipline(s) primarily addressed by each candidate journal;
- The approximate placement of each discipline on a continuum from basic to applied research;
- The approximate placement of each journal on a continuum from basic to applied, within each discipline addressed by that journal, to the extent that a given discipline is not strictly either basic or applied;
- The approximate placement of the use to be made of a given core list on a continuum from basic research to literature compaction;
- Citation patterns of each journal on a continuum from not cited to heavily cited;
- Citation patterns of each journal on a continuum from highly erratic to highly consistent.

Appendix 1

Summary of citations from three toxicology journals

The following issues of journals were examined for citations to journals. Citations to books, technical reports, and other non-serial matter were ignored.

- Journal of pharmacology and experimental therapeutics 194 (3), 195 (1), and 195 (2), dated September, October, and November 1975.
- Toxicology and applied pharmacology 33 (3), 34 (1), and 34 (2), dated September, October, and November 1975.
- Journal of toxicology and environmental health 1 (1) and 1 (2), dated September and November 1975.

Highly cited journals from JPET and TAP are given in table 11. Corresponding information for JTEH is not given, as issue number 2 was dedicated to tropical medicine; the tabulation by cited journal was therefore not considered typical of JTEH as a corpus.

Basic citation statistics for the three journals were:

	JPET	TAP	JTEH
no. of articles in the issues used . . .	65	52	26
number of journals cited	249	319	232
number of journal citations	1426	1098	756
mean citations per journal	5.73	3.44	3.26
mean citations per article	21.94	21.12	29.08
percentage of journal self-citations . . .	14.87	7.92	0.13
percentage of journals cited one time only	51.8	54.2	58.6
percentage of journals cited two times	13.7	16.7	13.4
percentage of journals cited more than 2 times	34.5	29.1	28.0

citations from Toxicology and applied pharmacology		citations from Journal of pharmacology and experimental therapeutics	
rank	title	rank	title
1	Toxicology and applied pharmacology	1	Journal of pharmacology and experimental therapeutics *
2	Biochemical pharmacology *	2	American journal of physiology *
3	Journal of pharmacology and experimental therapeutics *	3	British journal of pharmacology
4	Biochemical journal *	4	Nature *
5	Nature *	5	Federation proceedings *
6	Science *	6	Biochemical pharmacology *
7	Journal of biological chemistry *	7	Science *
8	Archives of environmental health	8	Journal of biological chemistry *
9	Pharmacological reviews *	9	Journal of physiology (London)
10	Experimental and molecular pathology	10	Journal of clinical investigation
11	Life sciences *	11	Proceedings of the Society for Experimental Biology & Medicine *
12	Proceedings of the Society for Experimental Biology & Medicine *	12	Pharmacological reviews *
13	American journal of physiology *	13	Circulation research
14	Federation proceedings *	14	Life sciences *
15	Laboratory investigation	15	Archives internationales de pharmacodynamie et de therapie
16	Journal of cell biology	16	European journal of pharmacology
17	Annals of the New York Academy of Science *	17	Proceedings of the National Academy of Sciences (USA)
18	Archives of biochemistry and biophysics	18	Biochimica et biophysica acta
19	Lancet	19	Annals of the New York Academy of Science *
20	Journal of pharmacy and pharmacology	20	Biochemical journal *

Table 11: highly cited journals from two leading toxicology journals. Titles marked with an asterisk appear on both lists above. The ranking algorithm used was formula 2, i.e., one point was awarded for the first citation to a journal in a paper, and 1/n was added for each nth additional citation to that journal.

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Appendix: Author's remarks during presentation of the preliminary version of this paper at ASIS-1976

The compilation of core lists has occupied the attention of information scientists since at least 1948, when Bradford published his book Documentation. Largely, work since 1948 has focused upon well-defined disciplines such as embryology, or upon fairly cohesive mission-oriented fields such as cancer research.

The present study was aimed at the compilation of a core list of journals in a field, toxicology, which exhibits these properties more than do most other fields:

First, it is largely multidisciplinary, but with a small disciplinary core.

Second, there is a paucity of toxicology-specific journals. There are fewer than a dozen, worldwide, that are devoted entirely to toxicology. And if we want to be really strict and eliminate journals covering both toxicology and pharmacology, only six remain.

Third, breadth of interest. While toxicology can still be thought of as the study of the adverse effects of chemical substances upon the body, several recent definitions broaden its scope to include virtually the entire area of chemical-biological interactions, with physical agents of biological change, such as radiation, added for good measure.

In addition to, and somewhat as a consequence of, the paucity of dedicated journals and the multidisciplinary breadth of interest, the fourth property of toxicology of interest here is the dispersion of its literature. None of the six strictly-toxicology journals appears, from data gathered in this study, to be as important in the field as, for instance, the Journal of biological chemistry or Archives of environmental health.

The first goal of this study was therefore to see if some bibliometric methods could be developed to result in some intuitively acceptable statements about the literature of toxicology, and the second goal was to come up with a core list of journals in toxicology.

As for the core list, a brief version, containing 68 titles, appears in part 2 of the Proceedings [of ASIS, 1976]. Because of page limitations, however, the full list of 94 titles, with additional supporting data and discussions, is deferred for later publication [pp.29-33 herein]. Ninety-

four titles may seem to be few, when some writers have mentioned numbers of journals as high as sixteen thousand as having some toxicological-biological interest, but the Bradford curve falls off quite sharply, and I believe that searching effort in this field beyond about 350 titles is wasted time, and beyond the 94 titles need only be done as a labor of love, or pursuant to a very generous Government grant.

The methodological goal, that of compiling a coherent core list from basically rather messy data, took a good deal of time, most of which was spent in exploring what turned out to be dead ends. Some of the candidate formulas looked extremely impressive, but these were the ones that failed to work, and I am happy to report that the two remaining, which were used to generate the core list, are fairly simple. These formulas are given in the Proceedings.

There are two formulas because the members of input lists of journals are either ranked or unranked, that is, in some instances one is working with lists of journals in alphabetical order, or by subject category, where each journal must be initially assumed to be of equal importance; and in other instances the list have some weights attached, such as counts of references to, or citations from, other journals.

In brief, the first formula gives journal scores as a function of the presence or absence of a journal on input lists of various lengths, total occurrance on all lists, and the mean length of all input lists, accounting for the Bradfordian assumption that presence on a short list should, other things being equal, be given more weight than presence on a long list, and also attempting to account for a reality that is not ordered as neatly as we might like it to be.

The second formula gives progressively less weight to additional occurrences, such as citations, in one place, thus discounting journals that are topic-specific so far as toxicology is concerned, such as the Journal of the American Water Works Association, while emphasizing journals that tend to be cited with moderate frequency in many toxicological papers, such as the British journal of industrial medicine, and which can then be taken as of general toxicological relevance and importance.

I would like to mention in closing the work of Gabriel Pinski of Computer Horizons, Inc. [see list of References], which seems to me to be quite valuable. The present study should be viewed as an attempt to analyze a rather disorganized multidisciplinary area, whereas Pinski placed journals in categories by requiring that "the candidate group of journals serve as the primary publication outlet for the area of study" [p.6], as measured by two-step citation maps. This

doesn't work in toxicology, and Pinski placed five toxicology journals in the more general, and at the same time more restricted, field of pharmacology, where by his methods they fit, and where they do not form a coherent subfield by themselves. [p. B-28]

END